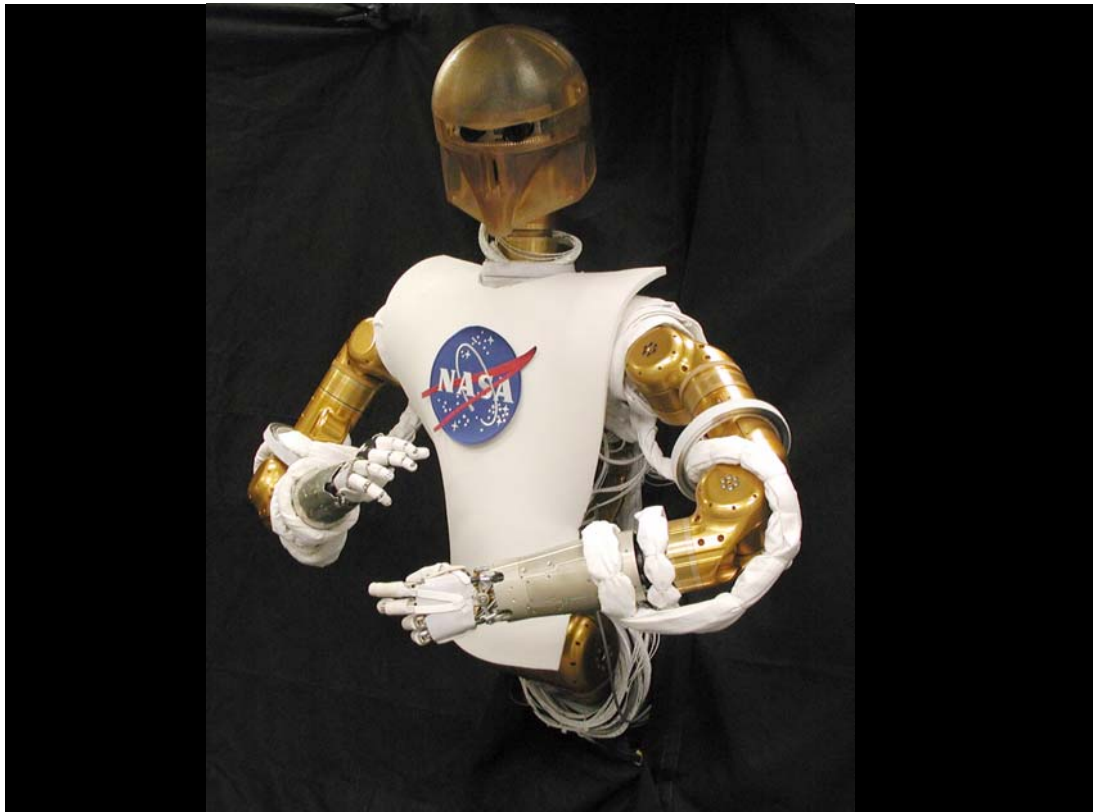




Spacebots

An Educator Guide



Spacebots

A Digital Learning Network Experience



Designed To Share

NASA's Space Exploration Program

This publication is in the public domain and is not protected by copyright. Permission is not required for duplication.



Table of Contents

Digital Learning Network Expedition	4
Expedition Overview	5
Grade Level	
Focus Question	
Instructional Objectives	
National Standards	6
Pre-Conference Requirements	11
Online Pre-Assessment	
Pre-Conference Requirement Questions	
Answers to Questions	
Expedition Videoconference Guidelines	15
Audience Guidelines	
Teacher Event Checklist	
Expedition Videoconference Outline	16
Pre-Classroom Activities	17
Post Conference	22
Online Post Assessment	
Post-conference Assessment Questions	
NASA Education Evaluation Information System	25
Certificate of Completion	26
Vocabulary	27
Resources	28
Background Information	29
Contributors and Developers	30



Digital Learning Network (DLN) Expedition

A DLN Expedition is a one time connection that allows students to experience NASA first-hand. Each expedition features an integrated educational package of grade-appropriate instruction and activities centered around a 50 minute videoconference. Students participate in a Question and Answer session with a NASA JSC education specialist or a NASA Subject Matter Expert.

SEQUENCE OF EVENTS

Pre-Conference Requirements

Online Pre-assessment A pre-assessment tool is available to determine the students' level of understanding prior to the videoconference. Suggested answers are included.

Expedition Videoconference

Expedition Videoconference (50 minute conference)

Robots have been a staple of our culture for the past half-century. We have all seen them in movies, on television, and in science fiction stories performing tasks that range from the mundane to the extraordinary. Because of the mental images we have of robots, sparked in great measure by the influence of science fiction, we often fail to recognize how widespread their use is in our daily lives. Everywhere we look, robots and automated systems do work for us and help make our lives more convenient if not easier. Often we do not recognize real robots because they differ from the images we have of them and from the jobs we tend to believe they do. As our society becomes more technologically dependent, however, the role of robots will increase significantly and knowing what they do and how they do it will be an important factor in many professions of the future. NASA already uses robotics technology to great extent in its exploration of space. During this Expedition, students and teachers will have an opportunity to learn firsthand about NASA's use of robots and how they are being designed and built to help humans explore the universe. Learn how NASA defines robotics, see how robotic systems are already widely used in the space program and what plans there are for future robotic applications. This interesting look into the world of space robotics will also highlight educational and professional opportunities that could be the catalyst that helps some students to identify a career path. So join us for this live, interactive learning session for a glimpse into the technologies of the 21st century happening now at NASA.

Post-Conference Requirements

Online Post-assessment

A post-assessment tool is available to determine changes in student levels of understanding.

NASA Education Evaluation Information System (NEEIS) Feedback Forms

Educator and student feedback forms are available online for all DLN events.



Expedition Overview

Grade Level(s) K-4

Focus Question

How are robotics used in space exploration and what are some of the career opportunities that exist in the field of robotics?

Instructional Objectives (accomplished through videoconferencing and pre- and post-activities)

- Define the term “robot” historically and identify everyday applications.
- Discuss the characteristics of robots and their role-use in space exploration.
- Explore career opportunities and the education required in the field of robotics.

National Standards

Table Below

Texas Standards

Table Below



National Standards

****PLEASE NOTE:** Due to the longevity of standard descriptions, expected student behaviors are listed below as text. The standard is listed in the chart.

National Science Education Standards (NSES) (from www.nap.edu)

<i>Science</i>	Think Like Robot	Robots in Action	Videoconfer- ence
Content Standard E: Science and Technology Abilities of technological design	X	X	X
Content Standard G: History and Nature of Science Science as a human endeavor	X	X	X

Student Behaviors:

Content Standard E: Science and Technology

Abilities of Technological Design (K-4): Children in grades K-4 understand and can carry out design activities earlier than they can inquiry activities, but they cannot easily tell the difference between the two, nor is it important whether they can. In grades K-4, children should have a variety of educational experiences that involve science and technology, sometimes in the same activity and other times separately. When the activities are informal and open, such as building a balance and comparing the weight of objects on it, it is difficult to separate inquiry from technological design. At other times, the distinction might be clear to adults but not to children.

Content Standard G: History and Nature of Science

Science as a human endeavor (K-4): Beginning in grades K-4, teachers should build on students' natural inclinations to ask questions and investigate their world. Groups of students can conduct investigations that begin with a question and progress toward communicating an answer to the question. For students in the early grades, teachers should emphasize the experiences of investigating and thinking about explanations and not overemphasize memorization of scientific terms and information. Students can learn some things about scientific inquiry and significant people from history, which will provide a foundation for the development of sophisticated ideas related to the history and nature of science that will be developed in later years. Through the use of short stories, films, videos, and other examples, elementary teachers can introduce interesting historical examples of women and men (including minorities and people with disabilities) who have made contributions to science. The stories can highlight how these scientists worked--that is, the questions, procedures, and contributions of diverse individuals to science and technology. In upper elementary grades, students can read and share stories that express the theme of this standard--science is a human endeavor.

International Technology Education Association (ITEA) (from www.iteaconnect.org)

ITEA <i>Technology</i>	Think Like Robot	Robots in Action	Videoconfer- ence
Standard 8: Students will develop an understanding of the attributes of design. (K-2) Everyone can design solutions to a problem. (3-5) The design process is a purposeful method of planning practical solutions to problems.	X	X	X
Standard 9: Students will develop an understanding of engineering design. (K-2) The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others. (3-5) The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.	X	X	X

Student Behaviors:

Standard 8: K-2 students should be introduced gradually to the importance of design, of visualizing objects, of translating ideas into sketches, and of using the design process to solve problems. 3-5 students should develop a more in-depth understanding of how a product or system is designed, developed, made, used, and assessed.

Standard 9: K-2 students will understand that the engineering design process is a method used to solve problems. All the products and systems they see around them must have been designed and made— from the fork they eat lunch with, to the toys they play with, to the clothes they wear. 3-5 students should realize that the purpose of engineering design process is to convert ideas into finished products and systems.

National Council of Teachers of Mathematics (from www.nctm.org)

NCTM <i>Mathematics</i>	Think Like Robot	Robots in Action	Videoconfer- ence
Standard 21: Connections (K-12) a. Recognize and use connections among mathematical ideas. b. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole. c. Recognize and apply mathematics in contexts outside of mathematics.	X	X	X
Standard 12: Understand measurable attributes of objects and the units, systems, and processes of measurement. (K-4) Select an appropriate unit and tool for the attribute being measured. (3-5) Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems	X	X	X



Texas Standards (TEKS)

Texas Essential Knowledge and Skills (TEKS)

All K-4 pre-activities meet the following Texas standards:

Science

2) Scientific processes. The student develops abilities necessary to do scientific inquiry in the field and the classroom. The student is expected to:

- (A) ask questions about organisms, objects, and events;
- (B) plan and conduct simple descriptive investigations;
- (C) compare results of investigations with what students and scientists know about the world;
- (D) gather information using simple equipment and tools to extend the senses;
- (E) construct reasonable explanations and draw conclusions using information and prior knowledge; and
- (F) communicate explanations about investigations.

(3) Scientific processes. The student knows that information and critical thinking are used in making decisions. The student is expected to:

- (A) make decisions using information;
- (B) discuss and justify the merits of decisions; and
- (C) explain a problem in his/her own words and identify a task and solution related to the problem.

Social Studies

16) Science, technology, and society. The student understands how science and technology have affected life, past and present. The student is expected to:

- (A) describe how science and technology have changed communication, transportation, and recreation; and

(B) explain how science and technology have changed the ways in which people meet basic needs.

English

15) Reading/inquiry/research. The student generates questions and conducts research about topics using information from a variety of sources, including selections read aloud. The student is expected to:

- (A) identify relevant questions for inquiry such as "What do pill bugs eat?" (K-3);
- (B) use pictures, print, and people to gather information and answer questions (K-1);
- (C) draw conclusions from information gathered (K-3);
- (D) use alphabetical order to locate information (1-3);
- (E) recognize and use parts of a book to locate information, including table of contents, chapter titles, guide words, and indices (1-3); and
- (F) locate important areas of the library/media center (K-1).



A week before the event, students will need to take the online pre-conference assessment. This short assessment will provide useful background information for the presenters to prepare for the videoconference.

- Page 11

- 3) Write a set of directions on how to move your arm from your side to scratch your nose. This will be a set of program directions similar to those written by engineers working to design a robotic system for movement to complete a task.

4) Match the following terms with their correct definitions:

Articulated		A mechanical or electromechanical device that performs human tasks, automatically or by remote control.
End Effector		The study and application of robot technology.
Degrees of Freedom		Each plane in which a robot can maneuver.
Anthropomorphic		To move by turning over and over. To rock back and forth.
Dexterity		Jointed arm.
Yaw		To move left or right with out turning over or moving up or down
Pitch		To control a device or object from a distant location.
Roll		To have human characteristics.
Autonomous		A robot that is operated remotely.
Robot		Device at the end of a robot arm that is used to grasp or engage objects.
Telerobotics		To rise up or dip down.
Teleoperation		Skill, flexibility, and range of mobility.
Robotics		Existing or functioning independently



Pre-Conference Requirements

Teacher's Page with suggested answers:

Answers to Pre and Post Assessment Questions

1. **Answers vary**
2. **Students draw picture**
3. **Answers vary**
4. **Articulated** – Jointed arm.

End Effector – Device at the end of a robot arm that is used to grasp or engage objects.

Degrees of Freedom – Each plane in which a robot can maneuver.

Robot – Mechanical or electromechanical device that performs human tasks, either automatically or by remote control (From the Czech word robota).

Robotics – Study and application of robot technology.

Telerobotics – Robot that is operated remotely.

Teleoperation – To control a device or object from a distant location.

Anthropomorphic – To have human characteristics.

Dexterity – Skill in using one's hands, body, or mind. Skill, flexibility, and range of mobility.

Pitch – To rise up or dip down.

Roll – To move by turning over and over. To rock back and forth.

Autonomous – existing or functioning independently.

Yaw – To move left or right without turning over or moving up or down.



Expedition Videoconference Guidelines

Audience Guidelines

Teachers, please review the following points with your students prior to the event:

- Videoconference is a two-way event. Students and NASA presenters can see and hear one another.
- Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.
- Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
- Teacher(s) should moderate students' questions and answers.

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	1. Print a copy of the module.
	2. Have the students complete the online pre-assessment.
	3. Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	4. Review the Audience Guidelines, which can be found in the previous section.
	Day of the Conference Requirements
	1. The students are encouraged to ask the NASA presenter qualifying questions about the Expedition.
	2. Follow up questions can be continued after the conference through e-mail.
	Post - Conference Requirements
	1. Have the students take the online Post-Assessment to demonstrate their knowledge of the subject.
	2. Use the provided rubric as guidelines for content and presentation criteria.
	3. Teacher(s) and students fill out the event feedback.



Expedition Videoconference Outline

Introduction to Challenge Videoconference

Robots have been a staple of our culture for the past half-century. We have all seen them in movies, on television, and in science fiction stories performing tasks that range from the mundane to the extraordinary. Because of the mental images we have of robots, sparked in great measure by the influence of science fiction, we often fail to recognize how widespread their use is in our daily lives. Everywhere we look, robots and automated systems do work for us and help make our lives more convenient if not easier. Often we do not recognize real robots because they differ from the images we have of them and from the jobs we tend to believe they do. As our society becomes more technologically dependent, however, the role of robots will increase significantly and knowing what they do and how they do it will be an important factor in many professions of the future. NASA already uses robotics technology to great extent in its exploration of space. During this Expedition, students and teachers will have an opportunity to learn firsthand about NASA's use of robots and how they are being designed and built to help humans explore the universe. Learn how NASA defines robotics, see how robotic systems are already widely used in the space program and what plans there are for future robotic applications. This interesting look into the world of space robotics will also highlight educational and professional opportunities that could be the catalyst that helps some students to identify a career path. So join us for this live, interactive learning session for a glimpse into the technologies of the 21st century happening now at NASA.

Outline for Video Conference

- I. Welcome**
- II. Introduction**
- III. History of Robots**
- IV. Today's Robots**
- V. Robotics Terms**
- VI. NASA Robots**
- VII. Careers**
- VIII. Q&A**
- IX. Good-Bye**



Pre-Classroom Activities



K-4 Activity #1



In the near future, astronauts will get a new helper in space. This new helper comes in the form of a **robot**. This robot will stay very busy. It will run science experiments when humans aren't around. It will make sure the air in the Space Station is healthy. It will also help with computer files and email.

This robot doesn't look like a human. It looks like a grapefruit, a large, red, flying grapefruit. It is packed with equipment that allows it to speak and understand our spoken language.

This robot moves around using fans. It zooms around like a **hummingbird**. It can go where humans can't. Astronauts can even teach it to fly behind or beside them as they work. It is very mobile and can understand much of what you want it to do.

This robot has four main jobs. One is to **monitor** the living area of the astronauts. The second is to communicate with the astronauts. The third is to go on **remote** missions and communicate back what it finds. The fourth is to support the work status of the astronauts and their mission.

The technology that has come about to create this robot is directly **transferable** to Earth.

This robot system could be used on subways and in factories. Robots can be assigned to do dangerous jobs, rather than humans.

Robots In Action

Teacher Sheet(s)

Objective:	To create, illustrate, and write about how robots could be used in a student's daily life.
Level:	K-4
Subjects(s):	Science, Language Arts
Prep Time:	Less than 10 minutes
Duration:	One Class Period
Materials Category:	General Classroom

Materials:

- Various books about robots
- Student Sheet
- Pencil
- Crayons

Related Links:

[Robotics](#)

Supporting Article(s):

Astronauts' Little Helpers

Pre-Lesson Instructions:

- To get the creative juices flowing, the teacher may want to share books about different robots, and discuss with the class different ways they are used. He/she may also want to use the related link listed on page 1 of the Teacher Sheets to share with the students.

Background Information:

An astronaut in space will get a little assistant in the near future. This assistant will come in the form of a robot and will follow the astronaut around, keeping track of the astronaut's schedule. It will check computer files, monitor experiments, and update inventories. This assistant will also keep a log of conditions on the Space Shuttle and Space Station. It will check levels of oxygen and hydrogen, and if emissions reach critical levels, the assistant will let everyone know. This assistant

is not humanoid; it's a robot that looks like a red grapefruit. It's packed full of sensors, miniaturized video equipment, wireless network equipment, and technology that allows the robot to understand spoken commands and reply with the same. This robot is eerily close to the flying robot that taught Luke Skywalker to fight with a light saber in the movie *Star Wars*.

Guidelines:

1. Read K-4 article, "Astronauts' Little Helpers," and discuss it.
2. Have students think of different ways they would use a robot. Would they use one for cleaning their rooms? Would they use one to do their homework? Have them really brainstorm different ways a robot would come in handy to them.
3. List their ideas on the board.
4. Hand out the Student Sheets to the students. Have them illustrate their specially designed robot. Make sure the illustration demonstrates what job the robot does for them. After their illustrations are complete, have the students write about their robot and the job it is doing for them.

Discussion/Wrap-up:

- Have the students share their illustrations and stories with the rest of the class. Hang the illustrations in the classroom and halls for display.

Extensions:

- Have the students publish their stories on the computer.
- For younger students, you may have the students skip a line on the Student Sheet for their writing level.
- Have the students create a robot using modeling clay.



K-4 Activity #2

Think Like A Robot

Teacher Sheet(s)

Objective: To demonstrate how hard it is to accurately guide a robot through simple tasks.

Level: K-4

Subjects(s): Physical Science

Prep Time: Less than 10 minutes

Duration: One Class Period

Materials Category: General Classroom

Materials:

- Blindfold
- Notebook
- Shoebox (or some other container that size)
- Baseball or tennis ball

Related Links:

[Robotics](#)

Supporting Article(s):

Astronauts' Little Helpers

Pre-Lesson Instructions:

None

Background Information:

Future robots will help astronauts inside the International Space Station. They will run science experiments when people aren't around. Exploration robots will land on and survey distant planets, moons, asteroids. These robots must be able to "think" for themselves. If a robot comes to a cliff on Mars, for example, it has to stop without a controller back on Earth

telling it to do so. Thinking robots are important because it takes many minutes to communicate between Earth and other planets, so human controllers can't respond fast enough to help a robot avoid a dangerous situation. Until robots become "true" thinking machines, able to understand their environment and make decisions about what to do to accomplish their mission, they will depend on controllers to guide them.

Guidelines:



1. Working with a partner, one student will take on the role of a robot, the other the controller. The person playing the robot should be securely blindfolded and given the ball.
2. The robot, following the verbal instructions from the controller, must move along a prescribed course (down an aisle and around a desk, for example) and then deposit the ball in the container. The robot can't talk during the first attempt and must follow directions given to it exactly ("turn right" doesn't necessarily mean all parts of the body). After the robot has successfully put the ball in the container, the robot and controller switch roles and try again.
3. Discuss how effective partners were with commands. Work out commands that are very specific to follow.
4. Repeat the mission again using a different route, taking a turn in each role. Were the commands clearer this time?

Discussion/Wrap-up:

- Ask the students:
What problems might you face if the robot wasn't as smart as you or your partner?
Answers will vary.
What activities or problems can you think of that a robot could solve or at least help with? Answers will vary. You may want to write their ideas on the board.

Extensions:



After the event students will need to take the online post-conference assessment. (These questions are the same questions used in the pre-assessment.) The short assessment will help us measure student learning and identify any changes that need to be made in future programs.

Post-Conference Assessment Questions

- 1) Provide a written definition of a Robot. What can a robot do? What does a Robot look like?

3) Write a set of directions on how to move your arm from your side to scratch your nose. This will be a set of program directions similar to those written by engineers working to design a robotic system for movement to complete a task.

4) Match the following terms with their correct definitions:

Articulated		A mechanical or electromechanical device that performs human tasks, automatically or by remote control.
End Effector		The study and application of robot technology.
Degrees of Freedom		Each plane in which a robot can maneuver.
Anthropomorphic		To move by turning over and over. To rock back and forth.
Dexterity		Jointed arm.
Yaw		To move left or right with out turning over or moving up or down
Pitch		To control a device or object from a distant location.
Roll		To have human characteristics.
Autonomous		A robot that is operated remotely.
Robot		Device at the end of a robot arm that is used to grasp or engage objects.
Telerobotics		To rise up or dip down.
Teleoperation		Skill, flexibility, and range of mobility.
Robotics		Existing or functioning independently



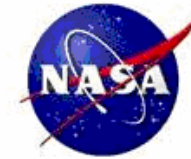
NASA Education Evaluation Information System (NEEIS)

Please complete an online evaluation form to provide feedback on the NASA Expedition.

Feedback from you and a few of your students would be appreciated.

<http://dln.nasa.gov/dln/content/feedback/>

National Aeronautics and Space Administration



NASA Digital Learning Network

presents

Certificate of Completion

to

for

Spacebots

Instructor

Date



Vocabulary

Articulated – Jointed arm.

End Effector – Device at the end of a robot arm that is used to grasp or engage objects

Degrees of Freedom – Each plane in which a robot can maneuver.

Robot – Mechanical or electromechanical device that performs human tasks, either automatically or by remote control (From the Czech word robota).

Robotics – Study and application of robot technology.

Telerobotics – Robot that is operated remotely.

Teleoperation – To control a device or object from a distant location.

Anthropomorphic – To have human characteristics.

Dexterity – Skill in using one's hands, body, or mind. Skill, flexibility, and range of mobility.

Pitch – To rise up or dip down.

Roll – To move by turning over and over. To rock back and forth.

Autonomous – existing or functioning independently.

Yaw – To move left or right without turning over or moving up or down.



Resources

Robotics Education Project - The NASA Robotics Education Project (RE) is dedicated to encouraging people to become involved in science and engineering, particularly building robots. Visit this website to learn about robotics competitions and how to get involved.

<http://robotics.nasa.gov/>

NASA Space Telerobotics Program - This program is an element of NASA's ongoing research program, under the responsibility of the Office of Space Science. The program is designed to develop telerobotic capabilities for remote mobility and manipulation, by merging robotics and teleoperations and creating new telerobotics technologies. http://ranier.hq.nasa.gov/telerobotics_page/telerobotics.shtm

A great NASA site for **robotic rover technology research** being conducted at the Jet Propulsion Lab in California.

<http://www-robotics.jpl.nasa.gov/videos/index.cfm>



Background Information

Robotics Competitions

<http://robotics.nasa.gov/students/challenge.php>

Ask a Robotocist.

<http://robotics.nasa.gov/students/robotics.php>

Phoenix Mars Mission: Just for Kids

<http://phoenix.lpl.arizona.edu/kids.php>

Mosaic Robot Puzzle

http://spaceplace.nasa.gov/en/kids/robots/robot_puzzle.shtml



Contributors and Developers

**Gus Possey
Nathan Lang**

**Museum of Flight
Johnson Space Center**

Special Thanks to the following organizations and people:

JSC Robotics